

REMARKS

In section 4 of the Office Action, the Examiner rejected claims 60, 61, 64-66, 68-71, 73, 75, 77-79, 81, 83, and 84 under 35 U.S.C. §103(a) as being unpatentable over Gosse in view of Webster and further in view of Iwamatsu.

Gosse shows in Figure 1 a block diagram of a decision feedback equalizer having a feed forward filter 10, a feedback filter 16, and a summer 14 that sums outputs from the feed forward filter 10 and the feedback filter 16 to provide soft outputs 17. The feedback filter 16 is provided with feedback based on symbol decisions derived from a branch metrics calculation 20, a branch metric compare 19, and a path history store 18.

The feedback filter 16 derives its input from the past history of the signals Y_k from the output of the feed forward filter 10. This past history is provided by storing, in the past history store 18, the symbol decision leading to a state S . This symbol decision is based on the branch metrics comparison performed by branch metric compare 19 using as inputs the branch metrics provided by the branch metric calculation 20, which is part of the Viterbi algorithm processor.

Thus, a vector of intermediate hard decisions is stored in the past history store 18 and is fed to the feedback filter 16. The signal y_k is applied to the branch metric calculator 20 which also receives the sum of an input d_{js} and the output of the feedback filter 16. The input d_{js} is a possible value for the symbol presently being calculated and corresponds to a possible transition in a trellis 22.

The symbol constellation is partitioned into two subsets as shown in Figure 2, the black circles and the shaded circles. Each subset contains four 8-PSK (Phase Shift Keyed) symbols. Figure 3 shows the state trellis. This state trellis includes the source and destination nodes of each of the possible signal paths in a two-state trellis.

Coset slicing is done by first determining the closest 8-PSK symbol, d , to the equalized signal $e_s(t)$. Then the algebraic sign of the quantity

$$\text{Phase Diff} = \text{Im}[dxSoftOut}',(t)]$$

is computed. A look-up table is used to determine the coset sliced symbols d_{s0} and d_{s1} .

Figure 5 is a block diagram of an iterative equalizer. A received signal is applied to a feed forward filter 42 of a decision feedback equalizer 40. The output of the feed forward filter 42 is applied through a switch 50 to one input of a summer 44, the output of which is applied to a processor 46, such as a Viterbi processor, and to a soft bit generator 48. The output of the processor 46 is applied through the switch 50 to a feedback filter 52 of the decision feedback equalizer 40. The output symbols of the feedback filter 52 are applied to the other input of the summer 44.

The output bits of the soft bit generator 48 are decoded by a channel decoder 56 that corrects for errors as a result of ISI.

In the first iterative cycle, the decision feedback equalizer 40 functions conventionally to estimate the entire sequence. In every subsequent iteration, the switch 50 is moved to its lower position to apply the output of the feed forward filter 42 through a buffer 64 to the summer 44, to disconnect the Feedback Filter 52 from the processor 46, and to apply a new signal to the input of the feedback filter 52. This new signal is produced by decoding at 56 the output of the decision feedback equalizer 40, by re-encoding the

decoded output at 58, by mapping the re-encoded output back to a symbol at 62, and by applying the remapped symbol through the switch 50 to the feedback filter 52.

The re-encoded sequence contains fewer errors than the output of the processor 46 because of the error correcting ability of the decoder 56.

A first test for convergence is made by a stopping rule 70. According to the stopping rule 70, at iteration i, if the output of the re-encoder 58 differs from the input of the decoder 56 by less than θ_{low} or more than θ_{high} , the iteration is stopped. Otherwise the stopping rule 72 is applied.

According to the stopping rule 72, the iteration is stopped if no re-equalization is necessary. Re-equalization is necessary if and only if the input to the decoder 56 at iteration i is different from that of iteration i-1.

The stopping Rule 70 uses the number of different bits between the output of the encoder 58 and the input of the encoder 56 as a measure of channel quality. If there are many different bits, then the channel is poor, and further iterations are useless. If there are only a few different bits, then the channel is good, and further iterations are also unnecessary.

The stopping rule 72 monitors the change in the output of the re-encoder 58 from one iteration to the next. If there is no change, no further iteration is necessary because further error correction is impossible.

In conjunction with the stopping rule 72, a new iteration will begin if the output of the re-encoder 58 at iteration i is different from that of iteration i-1. If there is a difference, the locations of the different bits is noted and only the bits or symbols associated with the affected location are used as the next input to the decision feedback filter 52.

Independent claim 60 - There are at least two reasons why independent claim 60 is patentable over Gosse in view of Webster and further in view of Iwamatsu.

First, contrary to the assertion of the Examiner, Gosse fails to disclose reliance on a reliability factor that is a measure of decoding reliability.

According to Gosse, the stopping rule 70 measures channel quality. Thus, Gosse directly contradicts the Examiner.

More specifically, the stopping rule 70 measures channel quality by comparing the output of the equalizer 40 to a reference (provided as the re-encoded

output of the decoder 56; the decoder 56 is able to provide some correction of the equalizer output). If the output of the equalizer 40 is significantly different than the reference, the channel is poor; whereas, if the output of the equalizer 40 is not significantly different than the reference, the channel is good.

If the stopping rule 70 were a measure of the reliability of the decoder 56, then re-encoding would not be required and the stopping rule 70 would instead make a measure that is internal to the decoder, such as looking at the decoding process itself as is done in the present application.

Moreover, neither Webster nor Iwamatsu discloses a reliability factor that is a measure of reliability of the decoding.

Webster states in paragraph 0018 that a received codeword is correlated by a codeword correlator with codewords of a multi-codeword set. The correlator output is examined to make a decision as to what codeword was actually transmitted. This decision is synthesized to produce a replica of the transmitted codeword. This synthesized transmitted codeword is convolved with an estimate of the channel impulse response derived from a

FIR filter to produce the post-cursor multipath echo in the signal received by the channel matched filter.

Webster states in paragraph 0019 that each codeword correlator differentially combines the contents of all of the chips that make up each received codeword with respective codeword-associated DFE feedback taps representing the post cursor multipath distortion echoes experienced by that particular codeword in the course of its transmission over the multipath channel from the transmitter. The post cursor multipath distortion may be removed either upstream or downstream of the codeword correlator.

Webster describes in connection with Figure 10 a DFE that cancels ISI in which the output of a channel matched filter 33 is coupled to a first input 101 of a difference combiner 102, which has a second input 103 coupled to receive a post-cursor echo produced by estimating the channel impulse response. The output 104 of the difference combiner 102 is coupled to a codeword correlator 31 whose output is supplied to a codeword decision operator 105. The codeword decision operator 105 examines all correlation results to make a decision as to what codeword was actually transmitted.

This codeword decision forms the basis for a replica of the originally transmitted codeword provided by a transmitted codeword synthesizer 106. This synthesized codeword is convolved as discussed above with an estimate of the channel impulse response 107 so as to produce a representation of the post-cursor multipath echo in the signal received by the channel matched filter 33. By applying this post-cursor echo to the difference combiner 102, the ISI contribution in the output of the channel matched filter 33 is effectively canceled from the input to the codeword processor 31.

The Examiner states that Webster generates a the reliability factor that is a measure of decoding reliability. However, applicants can find no such disclosure in Webster. Webster to be sure produces correlation peaks between the received codeword and reference codewords that could have been transmitted and then makes a decision of which codeword was transmitted based on which of these correlation peaks is largest.

However, Webster makes no judgment about how reliable this decoding process is by, for example, comparing the largest correlation peak to the next largest correlation peak.

Therefore, Webster fails to disclose a reliability factor that is a measure of reliability of the decoding.

Iwamatsu describes a de-spreading operation 15 that de-spreads an input IN. The de-spread signal is input to a Fast Hadamard Transform (FHT) 16 that performs a Fast Hadamard Transform to obtain a correlation between the de-spread signal and 64 predefined Walsh codes to obtain correlation values for every Walsh number (W₀, W₁, . . . , W₆₃). These correlation values are input to energy calculating units 17 to produce correlation energies (E₀, E₁, . . . , E₆₃) for the Walsh numbers. An FF unit 25 compensates for the delay of a reliability computing means 21. A correcting means 22 comprises a multiplier unit 24. A combining means 23 combines correlation values for every Walsh number calculated by a finger demodulating unit 11 and outputs from the correcting means 22. A maximum energy selecting unit 19 selects one Walsh number having a maximum correlation value and forwards this Walsh number to a Viterbi decoder 13.

The reliability computing means 21 computes the certainty of the value of each correlation energy as the reliability of the correlation energy for every Walsh

number based on the correlation performed by the Fast Hadamard Transform 16 between the de-spread signal and the 64 predefined Walsh codes. The reliability computing means 21 finds the receiving phase angle ϕ of every Walsh number for two consecutive Walsh symbol times, it also finds the phase difference angle $\Delta\phi$ between receiving phases corresponding to two consecutive Walsh symbol times, and it calculates the reliability for every Walsh number based on the phase difference angle $\Delta\phi$.

As can be seen, Iwamatsu does not generate a reliability factor that is a measure of reliability of the decoder 13. Instead, the reliability computer 21 computes demodulation reliability. (See column 2, lines 31-47.)

Because Gosse, Webster, and Iwamatsu all fail to disclose generating a reliability factor that is a measure of reliability of decoding, Gosse, Webster, and Iwamatsu would not have led the person of ordinary skill in the art to the invention of independent claim 60.

For this reason, independent claim 60 is not unpatentable over Gosse in view of Webster and further in view of Iwamatsu.

Second, Gosse, as discussed above, fails to disclose determining decoding reliability but does

determine the quality of the channel. Webster synthesizes the most likely codeword to have been transmitted and convolves this synthesized codeword with channel impulse response estimate in order to produce a post-cursor echo that is used to cancel ISI. ISI cancellation is of benefit to Gosse but would not be useful in generating a decoding reliability. Iwamatsu computes demodulation reliability but not decoding reliability. Because neither Gosse nor Webster utilize the same modulation technique as described in Iwamatsu, Iwamatsu's reliability computations would not be useful to either Gosse or Webster.

Accordingly, Gosse and Webster might be combined to provide ISI cancellation in Gosse but they would not have been combined to generate decoding reliability. Iwamatsu is not useful to either Gosse or Webster and, therefore, would not be combined with either of them.

For this additional reason, independent claim 60 is not unpatentable over Gosse in view of Webster and further in view of Iwamatsu.

Independent claims 66, 73, and 79 - For similar reasons, independent claims 66, 73, and 79 are not

unpatentable over Gosse in view of Webster and further in view of Iwamatsu.

Because independent claims 60, 66, 73, and 79 are not unpatentable over Gosse in view of Webster and further in view of Iwamatsu, dependent claims 61, 64, 65, 68-71, 75, 77, 78, 81, 83, and 84 per force are not unpatentable over Gosse in view of Webster and further in view of Iwamatsu.

In section 5 of the Office Action, the Examiner rejected claims 62, 67, 74, 76, 80, and 82 under 35 U.S.C. §103(a) as being unpatentable over Gosse in view of Webster and further in view of Iwamatsu and still further in view of Khayrallah.

However, Khayrallah fails to make up for the deficiencies of Gosse, Webster, and Iwamatsu. Therefore, independent claims 60, 66, 73, and 79 are not unpatentable over Gosse in view of Webster and further in view of Iwamatsu and still further in view of Khayrallah.

Because independent claims 60, 66, 73, and 79 are not unpatentable over Gosse in view of Webster and further in view of Iwamatsu and still further in view of Khayrallah, dependent claims 62, 67, 74, 76, 80, and 82 likewise are not unpatentable over Gosse in view of

Webster and further in view of Iwamatsu and still further
in view of Khayrallah.

CONCLUSION

In view of the above, allowance of all claims and issuance of the above captioned patent application are respectfully requested.

The Commissioner is hereby authorized to charge any fees which may be required, or to credit any overpayment to account No. 260175.

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